DOCUMENT RESUME

ED 031 031 40 EC 004 366

By-Boswell, James D.

Test Response Patterns which Differentiate between Two Levels of Behavior of Mentally Retarded Children. Final Report.

Utah Univ., Salt Lake City.
Spons Agency-Office of Education (DHEW), Washington, D.C. Bureau of Research.
Bureau No-BR-6-8127
Pub Date May 69
Grant-OEG-4-6-68127-1584
Note-71p.
EDRS Price MF-$0.50 HC-$3.65
Descriptors-Age Differences, *Discrimination Learning, Educable Mentally Handicapped, *Exceptional Child Research, Intelligence Differences, *Learning Characteristics, Maturation, *Mediation Theory, *Mentally Handicapped, Stimulus Behavior

The interrelations between mental age (MA), IQ, and mediation were studied in 72 retardates in special classes. Subjects were selected to fall into sexually balanced groups of six in 12 MA-IQ categories (IQ 50-59, 60-69, 70-79, and 80-89; MA 4-0 to 5-11, 6-0 to 7-11, and 8-0 to 9-11). The apparatus alternately displayed two pairs of stimuli, and three series of trials were run without interruption between them. Series 1 required discrimination, series 2 required discrimination reversal, and series 3 tested for mediation, or reversal. Although significance was not achieved in analyses of total number of reversal shift responses or of number of subjects achieving a reversal shift, there was a significant increase in both number of mediational responses and number of mediators between IQ levels 50-69 and 70-90. The two IQ levels also varied significantly in both cases. Significance was not found with respect to any levels of the MA variable. Results on series 1 and 2 showed significantly better performance within MA group with increasing MA; on series 2, the performance of nonreversers was significantly better. Thus, mediation did not increase with increasing MA, but did increase with increasing IQ. (JD)

ED031031

BR 6-8127
PA-40

OE-BR

FINAL REPORT
Project No. 6-8127
Grant No. OEG-4-6-068127-1584

PA 40

TEST RESPONSE PATTERNS WHICH DIFFERENTIATE BETWEEN TWO LEVELS OF BEHAVIOR OF MENTALLY RETARDED CHILDREN

May 1969

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

EC004 366 E

Final Report

Project No. 6-8127
Grant No. OEG-4-6-068127-1584

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

TEST RESPONSE PATTERNS WHICH DIFFERENTIATE BETWEEN TWO LEVELS OF BEHAVIOR OF MENTALLY RETARDED CHILDREN

James D. Boswell

University of Utah

Salt Lake City, Utah

May 1969

The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

TABLE OF CONTENTS

	PAGE
SUMMARY	i
CHAPTER	
I. INTRODUCTION, REVIEW OF LITERATURE, AND STATEMENT OF PROBLEM	1
Discrimination Learning	1
Discrimination Reversal Learning	5
Single-unit and Mediational S-R Learning Theory .	8
Statement of Problem	18
II. METHOD AND PROCEDURES	19
Subjects	19
Apparatus	21
Procedure	24
Recording of the Data	29
III. RESULTS AND DISCUSSION	30
IV. SUMMARY AND CONCLUSIONS	54
BIBLIOGRAPHY	59

LIST OF TABLES

TABLE		PAGE
I.	Distribution of Ss According to MA, CA, and IQ . .	22
II.	Number of Mediational Responses per MA-IQ Category	31
III.	Number of Subjects Mediating per MA-IQ Category .	32
IV.	Summary of Analysis of Variance for Number of Mediational Responses and Etas for MA and IQ . .	34
V.	Summary of Individual Degrees of Freedom Test for Total Number of Reversal Shift Responses	35
VI.	Summary of Analysis of Variance for Number of Mediational Subjects	37
VII.	Summary of Individual Degrees of Freedom Test for Subjects Achieving a Reversal Shift	38
VIII.	Descriptive Data on Reversing, Nonreversing, and Inconsistent Subjects According to IQ, MA, and CA	40
IX.	Number of Trials to Criterion in Series I and II for High and Low IQ Groups	48
X.	Number of Trials to Criterion in Series I and II for the Three MA Groups	49
XI.	Number of Trials to Reach Criterion as Related to Choice-Behavior in Series III	52

LIST OF FIGURES

FIGURE		PAGE
1.	A schematic representation of single-unit S-R theory and mediational theory	9
2.	Example of a Reversal and a Nonreversal Shift. (From Kendler & Kendler, 1962, p. 5)	11
3.	A Single-unit and Mediational S-R Analysis of a Reversal and Nonreversal Shift. (From Kendler & Kendler, 1962, p. 6).	12
4.	Illustration of MA-IQ Categories	20
5.	View of S Seated Before Discriminative Apparatus with One Pair of Stimuli in Position	23
6.	One Arrangement of the Stimuli in each Series with the Pattern of Reinforcement Indicated	26
7.	Percentage of Children at Each IQ Level Responding in Each Category	41
8.	Percentage of Children at Each MA Level Responding in Each Category	42
9.	Percentage of Children at Various Levels of Chronological Age Responding in Each Category	43

SUMMARY

Much interest has recently centered on discrimination learning, and especially discrimination reversal learning. Two major theoretical positions, namely, single-unit S-R theory and mediational S-R theory have been developed which provide a basis for interpreting performance on these two learning tasks. Single-unit S-R theory assumes a direct association between environmental stimuli and overt responses. Mediational S-R theory, however, assumes that an external stimulus evokes an implicit response which produces an implicit cue that is connected to the overt response. One learning situation which has been used to demonstrate both theoretical positions is that which follows the now-classical learning paradigm of reversal and nonreversal shifts (Kendler & Kendler, 1962). Kendler, Kendler, & Learnard (1962) used this model to show that with normal children there was an increase in the proportion of children achieving a reversal shift as CA increased. Reversal shift behavior served as the basis for inferring mediational ability. Their results supported the hypothesis of Kendler et al. (1962) that there is a hierarchy of developmental levels of learning ability, which in descending order are reversal learning (i.e., mediation), nonreversal learning (i.e., nonmediation), and inconsistent functioning.

The above investigators related mediation to CA in children of normal ability. Other research, however, suggests that CA by itself is an inadequate index of learning ability in the retarded, and that the critical variables to investigate are MA, IQ, and their interaction. For the purposes of this study, the paradigm and an apparatus similar

to that used by Kendler and Kendler (1962) were used to investigate the interrelations between MA, IQ, and mediation in mentally retarded individuals.

The original hypotheses of interest were:

(1) Regardless of IQ, the percentage of mentally retarded individuals mediating is a monotonically increasing function of MA.

(2) Regardless of MA, the percentage of mentally retarded individuals mediating is a monotonically increasing function of IQ.

The 72 Ss came from special education classes in public schools. They fell into 12 MA-IQ categories, with six Ss per category, equally distributed with respect to sex. These categories consisted of four levels of IQ: 50-59, 60-69, 70-79, 80-89, and three levels of MA: 4-0 to 5-11, 6-0 to 7-11, 8-0 to 9-11.

In Series I the Ss were trained to make an initial discrimination among two pairs of stimuli which varied along two dimensions, namely, brightness (black vs. white), and size (large vs. small). Only one dimension, i.e., brightness, was relevant. The correct response was always to black.

In Series II, just one of the pairs used in Series I was presented, and S was trained to make a reversal shift, i.e. reinforcement was to white, regardless of size.

In Series III (ten trials) both pairs of stimuli were again presented. The S's choice of response to the pair not presented in Series II served as the basis for interpreting how the reversal shift in Series II was made, i.e., according to single-unit or to mediational theory. If the response in this pair was to white in eight or more of

ten trials, he was considered a reverser (i.e. mediator). If there were two or less responses to white in the ten trials, S was considered a non-reverser, i.e. nonmediator. An S responding to white between two and eight times was considered an inconsistent S.

The two dependent variables were: (1) total number of mediational responses, and (2) number of Ss mediating.

The hypothesis that mediation would increase with increasing MA was not confirmed.

The hypothesis that mediation would increase with increasing IQ was confirmed, with the qualification that the significant increase occurred between the two lower IQ categories combined, and the two higher IQ categories combined.

In the study by Kendler, Kendler, & Learnard (1962) it was further found that reversers learned both the initial discrimination (Series I), and the discrimination reversal (Series II) significantly faster than nonreversers. But in the present study, there was no difference between reversers and nonreversers in speed of learning in Series I. In Series II, however, there was a significant difference between the variances of the reversers and nonreversers. The difference was in the opposite direction to that found by Kendler et al. (1962), i.e. the nonreversers performed significantly faster.

The IQ variable was found to be unrelated to speed of learning in Series I and II. However, speed of learning in both series was related to MA; there was a significant decrease in group variance with increasingly higher MA groups due to increasingly better performance of slow learners as MA increased. It was concluded that for mentally retarded

individuals below IQ 70, functioning beyond that implied by single-unit S-R theory could not be expected for the majority. It was pointed out, however, that in all MA-IQ categories there were Ss who mediated, and that there is some evidence mediational ability can be positively influenced under some conditions.

It was further concluded that the finding that mediation increased with increasing IQ, supported Kendler's hierarchy hypothesis with respect to mediators and nonmediators. However, the fact that in this study there was a far less percentage of inconsistent Ss than in the study by Kendler et al. (1962) with normals, cast some doubt on their hypothesis that inconsistent functioning represents the lowest form of learning.

CHAPTER I

INTRODUCTION, REVIEW OF LITERATURE AND STATEMENT OF PROBLEM

In recent years, there has been a rapid growth of interest among psychologists in the investigation of learning processes in mentally retarded individuals. Much of this interest has centered on discrimination learning and discrimination reversal learning. Two major theoretical positions, namely, single-unit S-R theory and mediational S-R theory, have been developed which provide a framework for interpreting the performance of the retarded on these two learning tasks. While most studies have compared the performance of retarded individuals with that of persons of normal ability, this study is directed specifically to the investigation of mediational learning ability within a retardate population. Since discrimination learning and discrimination reversal learning provide the basis for investigating mediational ability, let us turn now to a brief discussion of these two learning phenomena.

Discrimination Learning

The task of discriminating among stimuli, while initially studied as a sensory or perceptual process, was adopted early by psychologists as possibly providing a key to the understanding of much human learning. In the typical discrimination learning situation, two or more stimuli varying in one or more sensory dimensions are presented simultaneously, and the subject's task is to learn which stimulus is the correct (i.e., rewarded) one. Training is generally

continued until the subject's response to the correct stimulus can reliably be judged a function of learning rather than of chance. Reaching the criterion of learning constitutes the learning of a discrimination.

Only recently has any significant effort been directed toward the study of discrimination learning in the retarded. Characteristic of these studies has been the comparison of their performance with that of normals. Moreover, the predominant interest has been an attempt to determine whether normal and retarded individuals of the same or comparable mental age perform alike. A review of the literature indicates that the comparison of studies is complicated by the fact that they have employed varying experimental procedures, stimulus conditions have been different, there has been little control of one or more of the factors of MA, CA, AND IQ, and task complexity has varied from one experiment to another. There is, as Denny (1963) has noted in his excellent review of the research in learning and performance in retardation, a real need for further research to help bring together the diverse and often discrepant findings.

An attempt to establish the interrelationships between MA, CA, IQ, and learning poses real difficulties. It is not possible, for example, to have Ss matched on both MA and CA at the same time and have IQ vary, nor matched on IQ and CA while MA varies.

If it could be shown that CA is unrelated to learning among the retarded, the relationships of the constructs of MA and IQ to learning become determinable. There are some studies which support the assumption that CA is in

fact unrelated to learning in the retarded when the range of CA is restricted, and that therefore the critical variables to investigate are IQ and MA, separately, and in interaction. Studies on children by Ellis and Sloan (1959), Harter (1965), House & Zeaman (1960), and Stevenson & Odom (1965) have provided evidence of zero and negative correlations between CA and performance on discrimination learning tasks unless accompanied by large differences in MA. In the study by Harter (1965), it was further shown that the multiple correlations of learning with combined MA and CA measures were not higher than the correlation with MA alone. Also, in the study by House and Zeaman (1960), the partial correlations of learning and MA, with CA constant, were not appreciably less than the first order correlations of MA and learning.

There are few studies concerned with the relation between MA and learning. A notable exception is the study by Ellis and Sloan (1959). Subjects (Ss) in this study were 139 mentally retarded and 40 normal children grouped according to MA. The mean MAs for four levels of retardation were 4.1, 6.1, 7.7, and 9.7 ($\overline{CA}$s = 14-20). The two control groups of Ss of normal MA had mean CAs of 6.2 and 7.3. The task consisted of S being presented with two different pairs of objects. Three of the stimuli appeared in random fashion and the fourth, or odd one, constituted a correct choice. The criterion of learning was twenty successive correct responses. It was found that the higher the MA among the retarded, the better the learning, both in terms of asymptote and in rate of approaching asymptote. While very little learning occured in the 4.1 - MA group, the learning curves of the three higher MA levels were

negatively accelerated, learning in the 9.7 - MA group being fastest and reaching the highest level.

The relation of MA to learning set, which is more complex than, but similar to discrimination learning, is illustrated in a study by Ellis (1958). This study provides evidence that speed of acquisition of learning set is directly related to MA level. Fifty high-MA Ss ($\overline{MA} = 8$; $\overline{CA} = 14.75$) were compared with 40 low-MA Ss ($\overline{MA} = 5$; $\overline{CA} = 13.6$) on ten successive object-quality discrimination problems. Each problem was learned to a criterion of 20 successive correct responses. Learning sets developed quickly in both groups, but the high-MA group acquired them more rapidly and attained more efficient sets than the low-MA group.

It is obvious that much more research is needed in order to establish the nature of the relation between mental age and discrimination learning, and in order to determine the degree to which the deficit in the learning of the retarded is a function of MA as well as of IQ.

Studies on the relation between IQ and discrimination learning, with Ss matched on MA, have been extensively reviewed by Zeaman & House (unpublished manuscript). They noted that such studies have produced discrepant findings. Some have reported positive results, with better performance from the higher IQs (Baumeister, Beedle, & Urquhart, 1964; Ellis, Hawkins, & Pryer, 1963; Hoffman, 1963; House & Zeaman, 1958; House & Zeaman, 1960; Kass & Stevenson, 1961; Martin & Blum, 1961; Rieber, 1964; Rudel, 1959; Stevenson & Iscoe, 1955; and Stevenson & Zigler, 1957). Other of these studies

reported negative results, no differences being found among various levels of IQ (Hetherington, Ross, & Pick, 1964; Kass & Stevenson, 1961; Martin & Blum, 1961; Milgram & Furth, 1964; O'Connor & Hermelin, 1959; Sanders, Ross, & Heal, 1965; Stevenson, 1960; and Stevenson & Zigler, 1957). Three studies reported both negative and positive results for different comparisons (Kass & Stevenson, 1961; Martin & Blum, 1961; Stevenson & Zigler, 1957). On the basis of their analysis of the foregoing studies, Zeaman & House (unpublished manuscript) reasoned that the main difference between studies obtaining positive results and those obtaining negative results was the degree of task difficulty. Negative results came from those studies in which the task was either very easy or very difficult, producing attenuated performances. Zeaman and House, therefore, came to the conclusion that "at least a low positive correlation exists between IQ (with MA controlled) and performance in visual discrimination tasks when a wide range of IQs is sampled and tasks of intermediate difficulty are used."

In summary, it can be stated that the research on discrimination learning in the retarded provides evidence that their learning difficulties are related to IQ, and to MA. More research is needed, however, in order to make clearer the interrelationships among IQ, MA, and learning.

Discrimination Reversal Learning

Most discrimination learning tasks are concluded once S has reached a criterion of learning. In reversal problems, training is continued beyond

this point to determine whether learning a discrimination significantly influences S's ability to later choose the previously incorrect stimulus. This experimental procedure is useful because it allows one to infer clearly whether single-unit or mediational S-R learning theory better explains the results. Prior to a discussion of these theoretical positions, it will be well to note the results of some research in discrimination reversal learning.

Plenderleith (1956) compared normals ($\overline{CA}$=5-6) and retardates of the same MA on a discrimination reversal learning task. This study was important in showing that the time between the learning of an initial discrimination and the learning of a discrimination reversal can be a critical factor. The Ss were presented pairs of pictures, one of each pair constituting a correct number which was reinforced when chosen. Each pair of pictures was run through six trials, new pairs being presented until S reached the criterion of five correct responses after the initial trial on three successive pairs of pictures, and could verbalize the solution. Reversal learning followed (the previously incorrect member of each pair now being correct) immediately for one group of normals and retardates, 24 hours later for another group, and six weeks later for a third group. It was found that for the first two groups there were no differences between normals and retardates in number of trials needed to reach criterion, but that for Ss given reversal training six weeks after initial learning, the retarded Ss required significantly more trials than normals to reach criterion.

Another discrimination reversal experiment was carried out by Stevenson & Zigler (1957). Instead of S having to make a choice between two stimuli, he had to choose one of three gray blocks which varied in size. The Ss in this study were groups of normal children, retarded children, and retarded adults, all of the same MA. No significant differences were found in either original learning or in reversal learning. Reasoning that the task may have been too easy to differentiate the performance of normals from retardates, these investigators then carried out a second phase of the experiment with a more difficult problem and different Ss, but representing the same groups. However, instead of following the usual procedure of switching from one stimulus to another, as in the reversal situation, the switch was made from a stimulus to a position. Again, no significant differences were found in either original or subsequent learning among normal children, retarded children, and retarded adults.

A discrimination reversal study in which results different from the above two were obtained was that by O'Connor and Hermelin (1959) which involved effect of verbalization upon discrimination learning. In a first experiment, normals ($\overline{CA} = 5.1$) were compared with retardates ($\overline{CA} = 11.5$; $\overline{MA} = 4.9$) on learning a size discrimination (small square vs. large square), followed by an immediate reversal. The criterion of learning in each situation was 10 successive correct responses. In original learning, there was no difference between normals and retardates. In the reversal situation, however, the retardates learned significantly faster. The

interpretation, in line with Luria's (1957) theoretical position, was that the poorer performance of the normals was a function of the need to extinguish a verbal association not possessed by the retardates, in order to go on to achieve reversal learning. A second study, with a different group of retardates but identical problem situation, was carried out to test this hypothesis. This time the Ss were made to verbalize each response. Whereas Ss in the first experiment took many fewer trials to reverse than to learn, the Ss in the second experiment took more, and significantly more trials to reverse than the first group. The finding was interpreted as supporting Luria's hypothesis that a deficiency among retardates to form verbal-motor associations accounted for the difference in results between the first and second experiments.

Single-unit and Mediational S-R Learning Theory

No attempt was made in the foregoing studies to explain discrimination learning and discrimination reversal learning in comprehensive theoretical terms. However, much recent psychological research in the area of discrimination learning has been generated by two major theoretical positions. The first, which assumes a direct association between environmental stimuli and overt responses, is referred to as single-unit S-R theory (Spence, 1936). The second, which assumes that the external stimulus evokes an implicit response which produces an implicit cue that is connected to the overt response, is referred to as mediational S-R theory. Figure 1 schematically represents these respective theories.

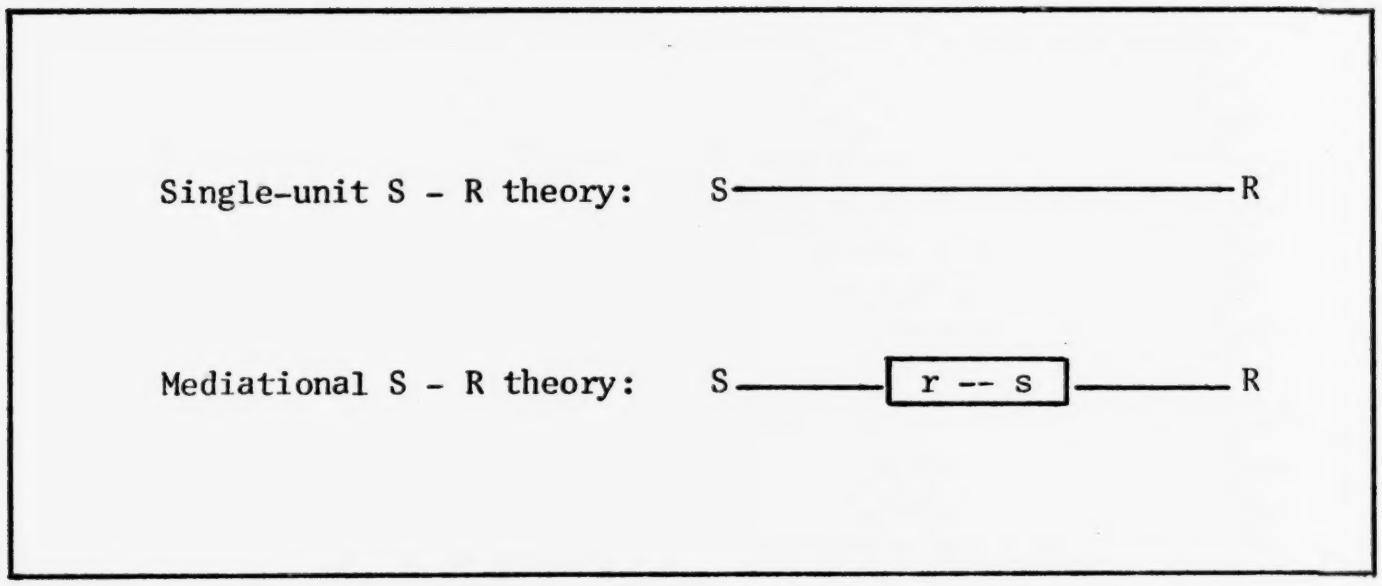

Fig. 1. A schematic representation of single-unit S-R theory and mediational S - R theory.

One type of learning situation which has been used to demonstrate these two theoretical positions is that which follows the now-classical learning paradigm of reversal and nonreversal shifts (Kendler and Kendler, 1962), illustrated in Figure 2.

The S is presented with a discrimination problem in which stimuli differ simultaneously on two dimensions (e.g., size: large vs. small; and brightness: e.g., black vs. white). Only one stimulus aspect of one of the dimensions is relevant (e.g., large). After reaching criterion (e.g., ten successive correct responses), a second discrimination is presented using the same stimuli, but in this case a shift in response is required because the reinforcement is reversed. In a reversal shift, S is required to respond to the opposite stimulus aspect of the previously relevant dimension (e.g., from large to small.) In a nonreversal shift, S is required to respond to one stimulus aspect of the previously present but irrelevant dimension (e.g., from large to white).

An analysis of reversal and nonreversal shift in terms of both single-unit and mediational S-R theories is represented in Figure 3. Single-unit S-R theory, which assumes environmental stimuli are connected directly to overt responses, predicts that reversal shift is less readily achieved than nonreversal shift. The reason is that reversal shift requires that a response previously reinforced be replaced by one that has been previously extinguished. For example, if the reinforced response in the initial discrimination was to "large," in a reversal shift this response must be replaced by a response to

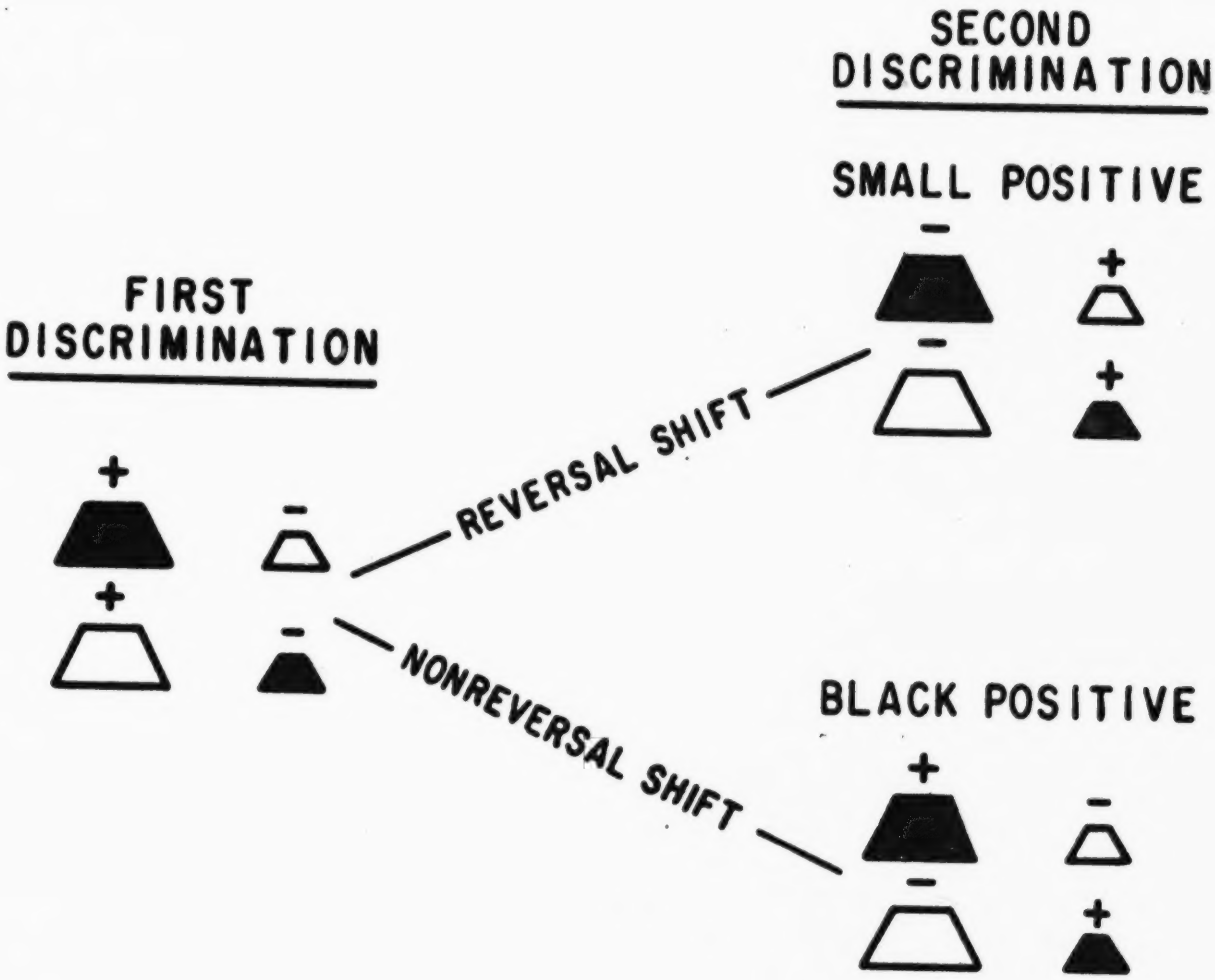

Fig. 2. Example of a reversal and a nonreversal shift. (From Kendler & Kendler, 1962, p. 5.)

SINGLE UNIT THEORY

MEDIATIONAL THEORY

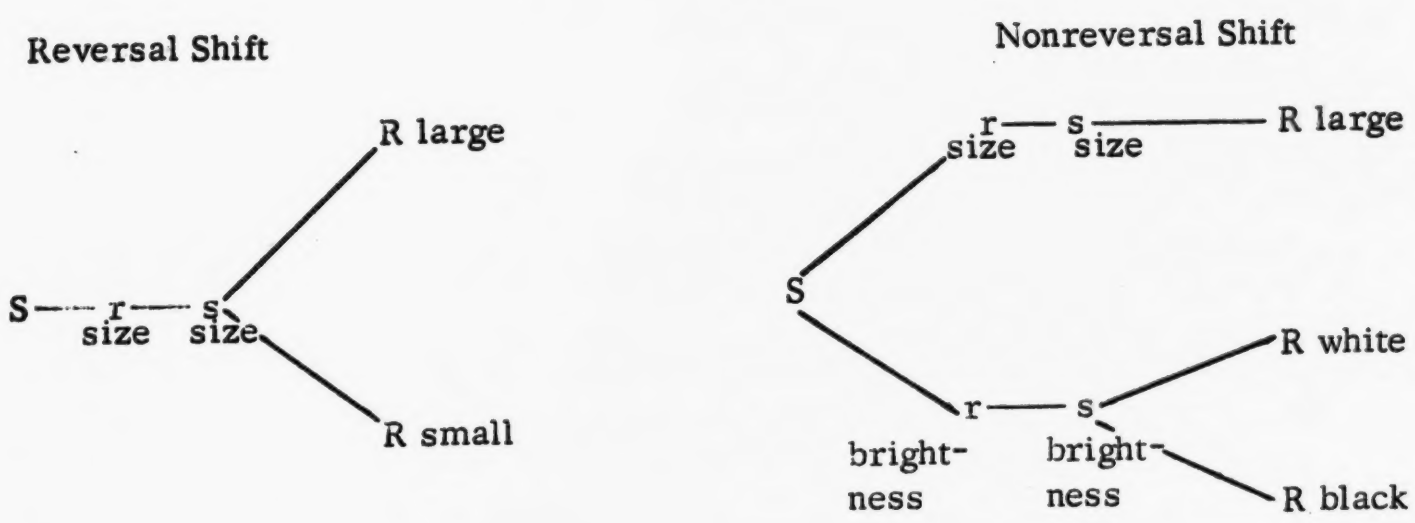

Fig. 3. A single-unit and mediational S-R analysis of a reversal and a nonreversal shift. (From Kendler & Kendler, 1962, p. 6.)

"small," a response which was previously extinguished. In a nonreversal shift, on the other hand, both stimulus aspects of the newly relevant dimension have been equally reinforced. This means that in order for a new discrimination to be achieved less extinction of a competing response is necessary than is the case in reversal shift.

Mediational theory, on the other hand, which assumes that implicit stimulus and response events intervene between environmental stimuli and observable responses, predicts greater facility of reversal over nonreversal shift. The reason is that the mediational events leading to the appropriate overt response in the initial discrimination remain present in the reversal shift; only the overt response has to be changed. In a nonreversal shift, however, new mediational events are required, as well as a new overt response. Consequently, the nonreversal shift is not as readily achieved as the reversal shift. Single-unit S-R theory has been used successfully to explain discrimination learning in infrahumans, typically in rats. Using white albino rats as Ss, Kelleher (1956) successfully predicted that nonreversal shift would be learned faster than reversal shift. This was a well designed study in which the possibility of the results in the shift situation being influenced by partial reinforcement in the initial or training discrimination situation was controlled in order to provide for a more adequate test of the two theoretical formulations. Kelleher concluded that it appeared the discrimination learning of inarticulate organisms is to be explained according to single-unit, not mediational S-R theory.

Studies with human Ss fall essentially into two categories, first, those in which Ss are trained in both shifts, and a comparison of the speed with which each shift is learned serves as the basis for theory testing, and, second, those in which the choice of shift is left to S and his preference leads to an interpretation of learning in terms of single-unit or mediational theory.

Three studies in the area of concept formation which employed a card sorting technique have shown that college students achieved a reversal shift faster than a nonreversal, these results being consistent with a mediational formulation (Buss, 1956; Harrow & Friedman, 1958; Kendler & D'Amato, 1955).

An interesting series of experiments in discrimination reversal learning have been carried out by Kendler & Kendler, 1959; Kendler, Kendler, & Wells, 1960; and Kendler, Kendler, & Learnard, 1962. These investigators reasoned that somewhere between the functioning of the retarded and college students there must be a point at which a transition from single-unit to mediational learning becomes characteristic. The first two studies compared the speed with which reversal and nonreversal shifts were learned. The Ss in the first study (Kendler & Kendler, 1959) were kindergarten children in a public school, ranging in chronological age from 58 to 78 months. MA and IQ were not controlled, but Ss presumably were of normal ability. It was found that when the group was taken as a whole, there was no difference in the speeds at which reversal and nonreversal shifts were learned. However, when the group was divided into fast and slow learners on the basis of performance in the initial discrimination, it was found that fast learners had performed in a

manner consistent with mediational theory, i.e., reversal was learned faster than nonreversal, while slow learners performed in terms of single-unit S-R theory, i.e., nonreversal was faster than reversal learning. It was concluded that as a group these kindergarten children were in the process of developing mediational behavior, the fast learners already having done so while the slow learners had not.

A second study (Kendler, Kendler, & Wells, 1960) was carried out to test the hypothesis arising from the first, namely, that children younger than kindergarteners should be able to learn a nonreversal shift significantly faster than a reversal shift. The Ss were nursery school children, ranging in chronological age from 33 to 64 months with a mean of 48.7. MA and IQ were not controlled. As was predicted, nursery school Ss performed significantly better in nonreversal than reversal shift.

The third discrimination reversal learning experiment (Kendler, Kendler, & Learnard, 1962) is most closely related to the present study. The experimental procedure was modified so that after S learned the initial discrimination he was presented with a situation in which he could respond in any of three ways: reversal shift, nonreversal shift, or inconsistent shift, i.e., a combination of reversal and nonreversal type responses. The choice of shift made was determined by S, and it was assumed that the choice made identified one as a mediator or nonmediator. The Ss were school children at five chronological age levels: 3, 4, 6, 8, and 10 years of age. The Ss were roughly equated as to IQs across age groups, through selected sub-tests of

the Stanford-Binet and the Wechsler Intelligence Scale for Children. The range of mean estimated IQ across the different age groups was from 112.0 to 120.2. The Ss were run through three Series. Series I constituted the initial learning in which the experimental task was that of learning to discriminate between two pairs of stimuli that differed simultaneously on two dimensions (size: large vs. small, and brightness: black vs. white) with only one dimension relevant. Series II consisted of presenting S with only one pair of the original pairs of stimuli, on which they were now trained to make a reversal shift. For example, if S was reinforced on white in Series I, he was reinforced on black in Series II; or if reinforced on small in Series I, he was reinforced on large in Series II. In Series III both pairs of stimuli were again presented. Reinforcement on the pair presented in Series II continued unchanged. However, both members of the pair not presented in Series II were now reinforced instead of only one member of the pair being reinforced as was the case in Series I. The kind of response S made to the pair not presented in Series II was noted. If S continued to make the same response to this pair as he had been trained to do in Series I, he was considered to have made a nonreversing response. If, however, his reversal training on the other pair in Series II led him to now choose the opposite number of the pair on which he was reinforced in Series I, he was said to have made a reversal shift. For example, if in Series I S was reinforced on black, and in Series II was reinforced for white on one of the pairs, in Series III he would continue to be reinforced on white for the pair presented in Series II but would be rewarded for either a black or white response on the pair not

presented in Series II. If in Series III S continued to respond to black on the pair not presented in Series II, he was considered to be a nonreverser, i.e., nonmediator. If, however, S chose to respond to white in Series III he was considered a reverser, i.e., mediator. Series III consisted of ten trials. Kendler, et al (1962) considered a mediator to be one who made eight or more reversal responses in Series III. A nonmediator was one who made two or less reversal responses. Those making between two and eight reversal responses were considered to be inconsistent. The main concern of this investigation was with the percentage of children who used a reversal shift as a function of chronological age. The results confirmed the prediction that with increasing chronological age an increasing proportion of children would choose a reversal shift. In keeping with the mediational hypothesis, non-reversal and inconsistent shifts were expected to decrease with age. It was found that inconsistent shift did decrease with age, but that nonreversal did not. The explanation proposed was in terms of inconsistent, nonreversal, and reversal shift. This order was suggested as representing increasing levels of development. With increasing CA more and more children move up from the level of inconsistent-shift-functioning to that of nonreversal functioning, and more move from nonreversal to reversal. As a result, one might expect the number of nonreversers to not change with increasing chronological age if the number of Ss moving from inconsistent to nonreversal was approximately equal to the number of Ss moving up from nonreversal to reversal. Although nonreversers did not decrease, Kendler concluded that the results

suggest that with increasing chronological age human development is characterized by a transition from single-unit S-R functioning to mediational behavior.

Statement of Problem

It is to be noted that the above research by Kendler, et al. (1959, 1960, 1962) has been based on children who are essentially of normal intellectual ability. The lack of corresponding research among mentally retarded children served as the basis for the present investigation. This study seeks to determine the degree of mediational ability which can be inferred in a retardate population.

The argument is presented that based on research cited previously, CA by itself is an inadequate index of learning ability in the retarded, and that the critical variables to investigate are MA, IQ, and their interaction.

Two hypotheses are to be tested:

1. There will be an increasing percentage of mentally retarded individuals who mediate with increasing MA, regardless of IQ.

2. There will be an increasing percentage of mentally retarded individuals who mediate with increasing IQ, regardless of MA.

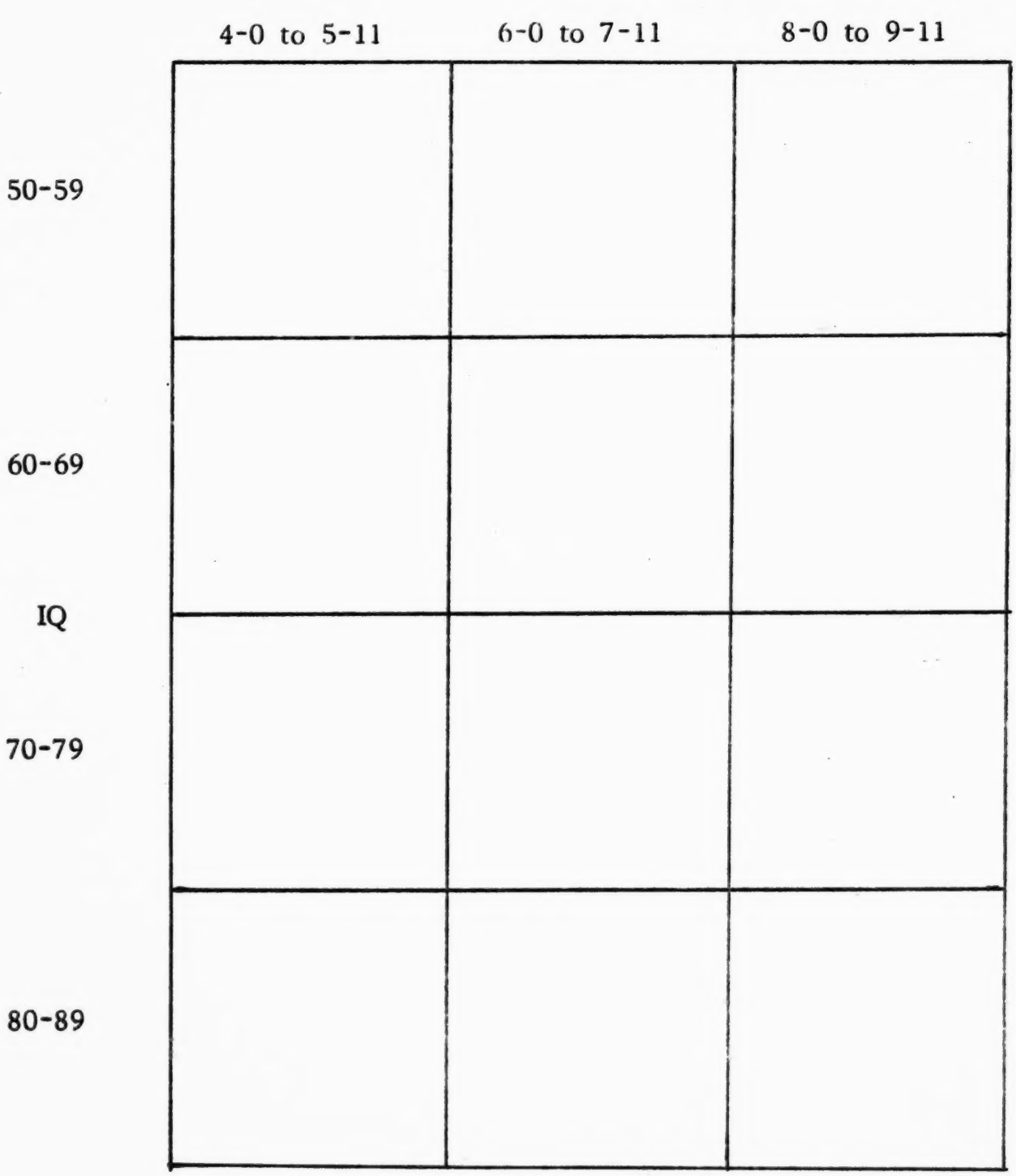

Fig. 4. Illustration of MA-IQ Categories
N = 72 (6 Ss per category)

CHAPTER II

METHOD AND PROCEDURES

There is a real need for greater understanding of learning phonomena in retarded children within the public school system. Knowledge of whether a retarded child is capable of mediational learning may, for example, be critical in determining the nature of teaching and training procedures. For the purposes of this study, therefore, it was decided to select the sample of Ss from this population.

Subjects

The 72 Ss in this experiment were mentally retarded individuals drawn from classes in special education in Salt Lake and Davis counties in Utah. The Ss used were those who fell into the MA-IQ categories indicated in Figure 4. There were six Ss per category, equally distributed with regard to sex.

The actual selection procedure was as follows: a list of the total population of mentally retarded children in the two counties indicated was obtained. The MA of these individuals was re-computed on the basis of present CA in order to bring the MA to current level. All those who fell into the required MA-IQ categories thus constituted the population from which the sample was drawn. However, those with known organic involvement or psychosis were excluded. Thirty-one of the required 72 Ss had been administered the Stanford-Binet Intelligence Scale, Form L-M, within the past year. They were accepted as Ss without further qualification. Those Ss selected who had not been tested

within the past year were administered this intelligence test by a competent psychologist in order to bring their evaluations up to date. If an S no longer remained in a required category after being tested, he was excluded from further consideration. Another S from the category in question would then be randomly selected. All told it was necessary to administer the intelligence test to a total of 72 children in order to obtain the other 41 Ss for the required MA-IQ categories. Within each category, the Ss were randomly selected for each sex. Table I shows the overall distribution of Ss according to MA, IQ, and CA.

Apparatus

The discriminative apparatus (see Figure 5) was patterned closely after that of Kendler, et al. (1962, p. 574). It consisted of a 1/4 inch plywood board 16 inches high, 14 inches wide, held in vertical position on a short base. Paired windows, each 5 inches square, were arranged side by side on the frontal surface. The discriminanda consisted of four pasteboard cards 5 1/2 inches square on which the stimuli were mounted. The entire apparatus and pasteboard cards were painted a light gray. The stimuli were black and white squares, both of which were in two sizes. The two large stimuli were 3 inches square, and the two small stimuli were 1 inch square. Each pasteboard could be inserted in slots behind the windows in order to display the stimuli.

TABLE I

DISTRIBUTION OF Ss ACCORDING TO MA, CA, AND IQ
(N = 72)

	mean	range	s
MA (years)	7-1	4-5 to 9-11	1-5
IQ	69.58	50-88	11.05
CA (years)	10-7	5-10 to 19-10	3-3

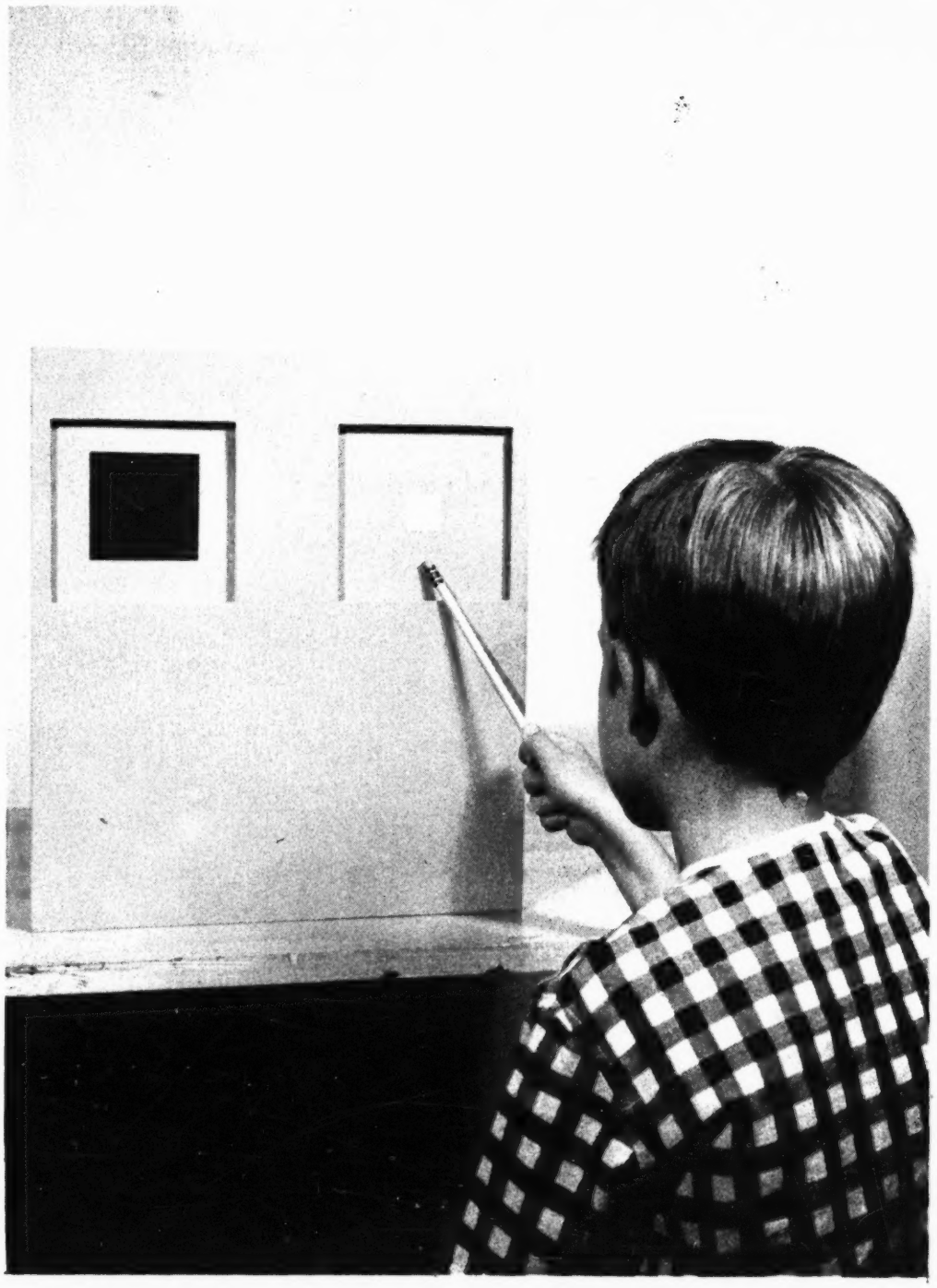

Fig. 5. View of S seated before discriminative apparatus with one pair of stimuli in position.

Procedure

The 31 Ss who had been administered the intelligence test within the past year and who met the requirements of the study were seen once only for the purpose of participating in the experiment. The remaining 41 Ss took part in the experiment approximately two weeks after the intelligence test had been administered to them.

Two experimenters (E 1, E 2) were used. Each E ran 36 Ss individually in a quiet room in the school in which S was a student. Every S completed the experimental tasks in a single session which lasted anywhere from 15 to 45 minutes, depending on S's speed of learning.

The S was seated in front of the apparatus which was placed on a narrow table, with E behind. To the right of the apparatus, in plain view of S but out of his reach, was a clear glass jar containing five new pennies. In addition, a supply of new pennies was placed behind the apparatus out of the sight of S. The S was reinforced by E placing one of these pennies in the glass jar for each correct response made. Likewise each time S made an incorrect response, E withdrew a penny from the jar and placed it behind the apparatus out of S's sight. After S was seated the following instructions were given verbally by E:

> All right (S's name). We're going to play a game. I'm going to show you some pictures. One will be in this window and one will be in this window (E pointed). One picture will be a winning picture and one will be a losing picture. I want you to figure out which one is the winning picture. When you figure out the winning picture, just point to it like this with the eraser (E illustrated and handed S an unsharpened pencil with eraser). Every time you point to the winning picture I'll put a new penny

> in this jar for you. But when you point to a losing picture, I'll take a penny back. Remember, I want you to figure out which is the winning picture. Every time you point to the winning picture I'll put a penny in the jar for you, and every time you point to the losing picture I'll have to take a penny back. I want you to win as many pennies as you can, and you can keep them after the game is over. We're going to start by giving you five free pennies in the jar right now. All right, let's begin.

The actual experiment procedure was similar to that of Kendler, et al, (1962, pp. 575-576). The four stimuli were so paired as to vary simultaneously along two dimensions, i.e., small black was always paired with large white (SB: LW), and large black with small white (LB: SW). A pasteboard screen was used to shield E's manipulation of the stimuli from S. Some minor variations were made in the manner of reinforcing S, and in the reinforcements used. Kendler et al. had Ss press sticks to indicate their choice instead of pointing to the picture, and correct responses were rewarded automatically with marbles, only one of which S was allowed to keep at the end of the "game." In the present study, the manner in which S indicated his response, and the manner in which he was reinforced, were chosen because they were believed to be simpler for the child, a fact that might be important in reducing experimental error when working with retarded Ss. Likewise, the reinforcement itself, i.e., new pennies, was felt to have a higher and more consistent reward value for all Ss than marbles.

Immediately following the instructions, S was run through three series of trials with no break between them. Figure 6 illustrates one arrangement of the stimuli in each series, with the pattern of reinforcement indicated.

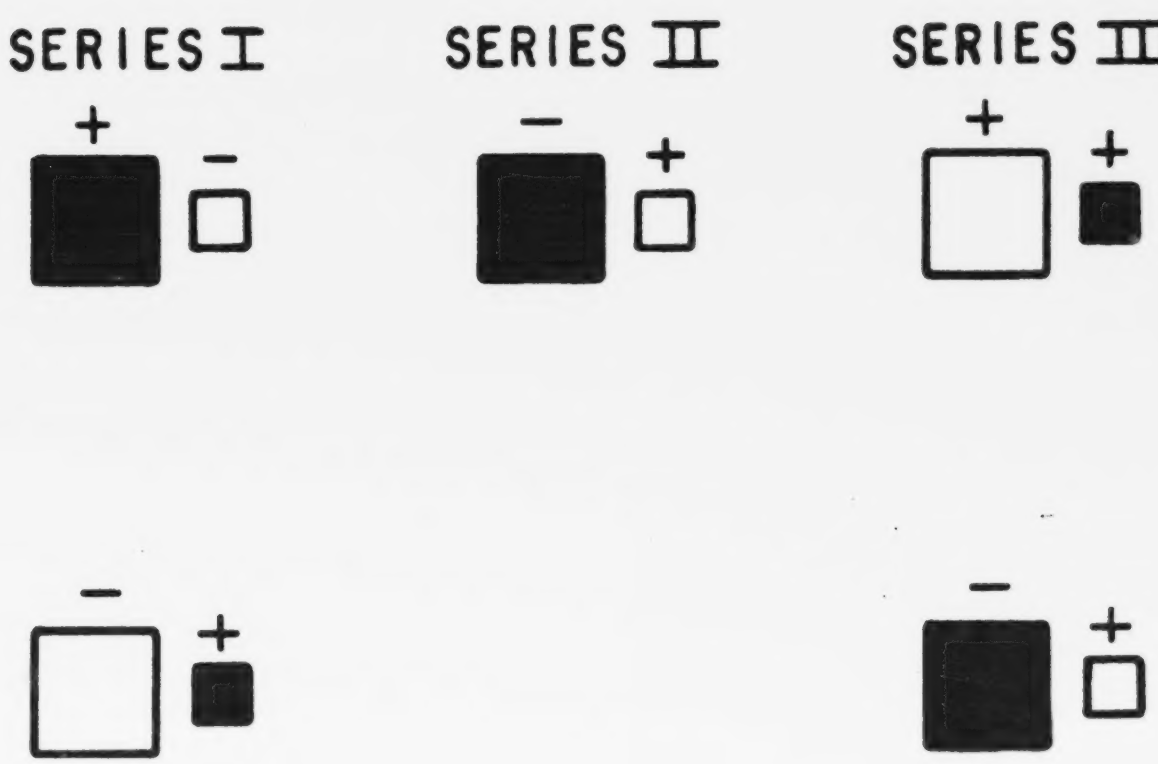

Fig. 6. Illustration of one of the arrangements of stimuli and reinforcement used in the experiment. (From Kendler, Kendler, & Learnard, 1962, p. 575.)

Throughout the entire experiment the relevant dimension was brightness, size being the irrelevant dimension.

In Series I, S was trained to make an initial discrimination; in Series II he was trained to make a reversal discrimination on just one of the pairs from Series I, while Series III constituted the test-trials which provided the basis for determining whether the shift in Series II was made according to single-unit or mediational theory.

In Series I every S was presented with the pairs of stimuli as indicated in Figure 6, beginning with large black, small white (LB:SW). The pairs of stimuli were presented alternately in a prearranged sequence which was the same for all Ss. Also, the correct member of each pair appeared on the right and left equally often but never more than twice in succession in either position. In this first series, S was reinforced with a penny for every response to black. Whenever he pointed to either of the white stimuli, one penny was taken from him. Training was continued to a criterion of 9 out of 10 correct responses.

Series II followed without interruption. In this series, however, one-half of the Ss were trained on one pair, and the other half on the other pair of stimuli. For example, half were presented with LB:SW, half with LW:SB. For all Ss the previously positive stimulus (black) became negative while the previously negative stimulus (white) became positive, regardless of size. Learning this second discrimination would be achieved by responding to size, to brightness, or to both. As in Series I, training was continued to the same criterion of 9 out of 10 correct responses.

The purpose of Series III was to determine the basis on which S learned the Series II discrimination, i.e., whether he responded in terms of single-unit S-R theory or in terms of mediational theory. In this series, the same pairs of stimuli that appeared in Series I were presented alternately. This time, however, S was reinforced for a response to either member of the pair which had not been presented to him in Series II. For example, if in Series II he was presented with LB:SW and was reinforced on SW, he would continue to be reinforced on SW in Series III, but when presented with the stimuli not given in Series II (LW:SB), he would be reinforced on both LW and SB. If S in Series II responded to the whiteness of the SW square, he would be expected to respond positively to the LW square as opposed to SB when presented with this choice in Series III. Since this response is to the concept of brightness, it would represent a reversal shift, i.e., mediation. If, however, Ss responded to the concept of size in the positively reinforced SW square in Series II, then he would be expected to respond to SB over LW in Series III; this would represent a nonreversal shift. But if in Series II S responded to both size and brightness, he would in Series III, presumably divide his responses between LW and SB; this would be an inconsistent form of responding and would represent neither reversal nor nonreversal shift. Each pair of stimuli was presented ten times in Series III in the same order as in Series I. Responses to the pair not presented in Series II, i.e., the test pair, were recorded for the purpose of classifying each S as a reverser, nonreverser, or inconsistent (Kendler et al., 1962).

Recording of the Data

The number of responses presumed to indicate mediation was recorded for each S. The same scoring system used by Kendler et al. (1962) was adopted. A reverser (i.e., mediator) was considered to be one who made eight or more reversal responses in Series III, a nonreverser (i.e., nonmediator) was one who made two or less, and an inconsistent person was one who made between two and eight reversal responses in Series III.

For the purpose of further analysis, the number of trials taken by each S to reach criterion in Series I and Series II was recorded. Also, any errors made in Series III on the control pair were noted, i.e., the pair used in Series II.

CHAPTER III

RESULTS AND DISCUSSION

The present research was concerned basically with the investigation in retarded individuals of what is presumed to be mediation. Specifically, the concern was with determining the interrelations among mediation, MA, and IQ. The presence or absence of mediation was inferred from performance in Series III. Consequently, this is where analysis of the data begins. Tables II and III show the main results of the experiment. Table II shows the total number of mediational responses per MA-IQ category, while Table III shows the number of Ss who mediated in each MA-IQ category.

Prior to analyzing the data proper, a chi square (X^2) test of independence was done to determine whether the experimenter (E) variable influenced the results obtained. In terms of both major variables of MA and IQ, the X^2-tests between number of mediational responses obtained by each E failed to approach statistical significance at the 5 per cent level (X^2 on the MA variable was .59, df = 2; on the IQ variable, using high-low split at IQ 70 it was .23, df = 3). The X^2 between Es regarding number of mediational Ss also failed to reach statistical significance on both the MA variable ($X^2 = 4.32$, df = 2) and on IQ, again using the high-low split at IQ 70 ($X^2 = 1.44$, df = 3). The data obtained by the respective Es were therefore combined for all subsequent analyses.

TABLE II

NUMBER OF MEDIATIONAL RESPONSES
PER MA-IQ CATEGORY

IQ	MA 4-0 to 5-11	MA 6-0 to 7-11	MA 8-0 to 9-11	
50-59	26	26	30	82
60-69	14	47	12	73
70-79	26	50	48	124
80-89	56	31	30	117
	122	154	120	396

TABLE III

NUMBER OF SUBJECTS MEDIATING
PER MA-IQ CATEGORY

IQ \ MA	4-0 to 5-11	6-0 to 7-11	8-0 to 9-11	
50-59	2	2	3	7
60-69	1	4	1	6
70-79	2	5	5	12
80-89	6	3	3	12
	11	14	12	37

It will be noted that the categories of the data in Tables II and III are appropriate for an analysis of variance design to test for relationship between MA and mediation, IQ and mediation, and the interaction between MA and IQ in relation to mediation. It can be seen from observation of the data in both tables that increase in MA and IQ is not accompanied by a regular and corresponding increase in mediational responses, or in number of Ss mediating. In both tables, however, there appears to be a significant increase in both number of mediational responses and in number of Ss mediating, beginning at the IQ 70 level. An overall analysis of variance as well as eta was computed from the data in Table II. The results are shown in Table IV. Neither the analysis of variance, nor the correlation was significant.

An individual degrees of freedom test was done next to test the a priori hypotheses that mediation would increase with increasing MA, and with increasing IQ. The individual degrees of freedom test (Li, 1957, pp. 228-229) was computed for both the MA and IQ variables for total number of reversal shift responses. Table V reports the results of these analyses. It will be noted from Table II that the totals of the four IQ levels show no continuous increase in mediational responses with increasing IQ. But there appears to be a considerable discrepancy in number of mediational responses between the total of the two low IQ levels combined, and the two high IQ levels combined. As can be seen in Table V, there is a significant difference between the number of mediational responses of the two low IQ levels combined, and the two upper levels combined (P .025). The difference between the 60- and 70-IQ levels

TABLE IV

SUMMARY OF ANALYSIS OF VARIANCE FOR NUMBER OF MEDIATIONAL RESPONSES AND ETAS (η) FOR MA AND IQ

Source	df	SS	MS	F	P	η	P
MA	2	30.33	25.72	1.32	n.s.	.14	n.s.
IQ	3	106.33	35.44	2.21	.09	.19	n.s.
MAxIQ	6	170.00	28.31	1.45	n.s.		
Residual	60	1,170.67	19.51				
Total	71	1,522.61					

TABLE V

SUMMARY OF INDIVIDUAL DEGREES OF FREEDOM TEST FOR TOTAL NUMBER OF REVERSAL SHIFT RESPONSES (N = 396)

	Comparisons	F	P
	50s & 60s vs. 70s & 80s	5.26	.025
IQ:	50s vs. 60s	2.25	n.s.
	60x vs. 70s	3.70	.07
MA:	4-6 & 6-8 vs. 8-10	.46	n.s.
	6-8 vs. 8-10	1.23	n.s.

approached significance (P .07). All other statistical tests between IQ levels were not significant at the .05 level. The mean for the combined lower two IQ levels was 4.3 with a standard deviation (s) of 4.55, while the mean for the upper two levels combined was 6.7 with s of 4.36. All statistical tests with respect to the MA variable failed to achieve significance.

For comparative purposes, a further test employing X^2 was next done for IQ. Again a significant difference ($P < .001$) was found between the upper two IQ levels combined, and the lower two combined, for number of mediational responses ($X^2 = 18.68$, $df = 2$).

In order to obtain another measure of mediation besides the one above, an overall analysis of variance was done on the number of Ss who mediated (see Table III). Inasmuch as this data yields information in terms of frequencies, it was converted to binomial form for purposes of the analysis (Li, 1957, p. 416 ff). The Ss were scored as either 0 or 1, a zero score representing an S who did not achieve a reversal shift, while 1 represented one who did. The figures in the categories of Table III thus represent number of Ss who are scored as 1, i.e., as having made a reversal shift. The results of the analysis are shown in Table VI. No significant difference was found for either the MA or IQ variables.

Again, as a further test of the a priori hypotheses that mediation would increase with increasing MA, and with increasing IQ, an individual degrees of freedom test was next done. The results of the comparisons of various MA and IQ levels are shown in Table VII. It will be seen that the difference between

TABLE VI

SUMMARY OF ANALYSIS OF VARIANCE FOR NUMBER OF MEDIATIONAL SUBJECTS

Source	df	SS	MS	F	P
MA	2	.19	.095	.047	n.s.
IQ	3	1.71	.57	2,59	,08
MA x IQ	6	2.92	.49	2.23	.06
Residual	60	13.17	.22		
Total	71	17.99			

TABLE VII

SUMMARY OF INDIVIDUAL DEGREES OF FREEDOM TEST FOR TOTAL NUMBER OF SUBJECTS ACHIEVING A REVERSAL SHIFT (N = 72)

	Comparisons	F	P
	50s & 60s vs. 70s & 80s	7.64	.01
IQ:	50s vs. 60s	.12	n.s.
	60s vs. 70s	4.54	.05
	4-6 vs. 6-8	.82	n.s.
MA:	4-6 & 6-8 vs. 8-10	.026	n.s.

the upper two IQ levels combined, and the lower two combined, is significant at the .01 level. Also, the difference between the 60- and 70-IQ levels is significant at the .04 level. All other statistical tests, including those on the MA variable, failed to achieve significance. As was done for the data of Table II, X^2 was done using the IQ variable with the same high-low split on number of Ss mediating. The X^2 of 6.73 (df = 2) was significant at the .05 level.

The range, means, medians, and standard deviations were computed for both reversing and nonreversing Ss across IQ, MA, and CA variables. These data appear in Table VIII, along with appropriate tests for statistical significance. Statistical tests were not done for the inconsistent Ss because there were only five cases in this category. As can be seen from this table, the only significant difference found between reversers and nonreversers was on the IQ variable, the obtained t of 2.19 being significant at the .025 level. Figures 7, 8, and 9 graphically present the percentage of Ss at the various IQ, MA, and CA levels who were classified as reversers, nonreversers, and inconsistent.

Figure 7 shows even more clearly than Table III the sharp increase in the percentage of reversing Ss at the 70 IQ level, and the similarly sharp decrease in percentage of nonreversers at the same IQ level. The slight drop for the inconsistents can hardly be considered important inasmuch as there are only five Ss in this category.

TABLE VIII

DESCRIPTIVE DATA ON REVERSING, NONREVERSING, AND INCONSISTENT Ss ACCORDING TO IQ, MA, AND CA (N=72)

		N	Range	Mean	Median	s	t
IQ:	Reversers	37	50 - 88	72.43	73.5	10.81	2.19**
	Nonreversers	30	50 - 84	66.63	64.5	10.42	
	Inconsistents	5	51 - 80	62.20			
MA:	Reversers	37	4-5 to 9-10	7-2	7-3	16.16	
	Nonreversers	30	5-10 to 9-11	7-2	7-3	18.77	
	Inconsistents	5	5-2 to 7-1	6-2			
CA:	Reversers	37	5-10 to 19-3	10-4	9-11	3-1	1.33a
	Nonreversers	30	6-2 to 19-10	11-5	10-11	3-6	
	Inconsistents	5	6-10 to 11-2	9-6			

** significant at .025

a = n.s.

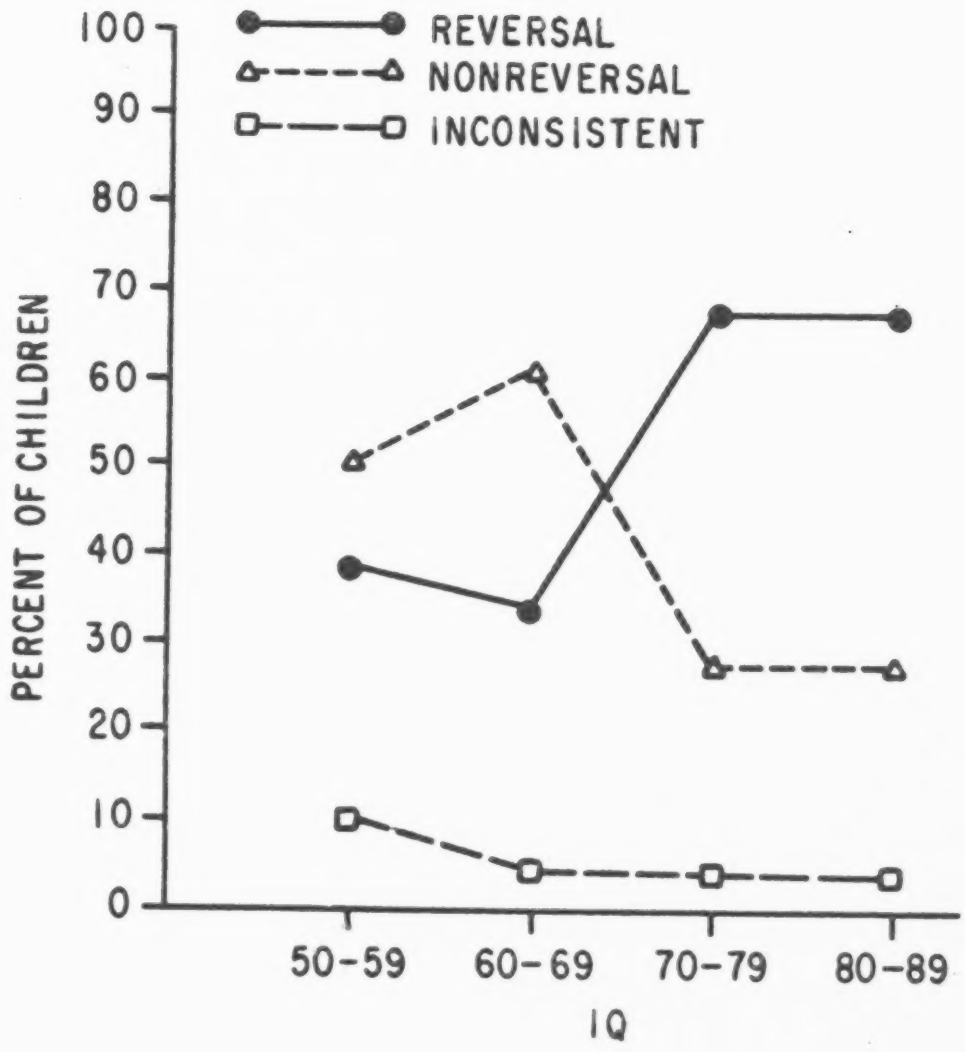

Fig. 7. Percentage of children at each IQ level responding in each category.

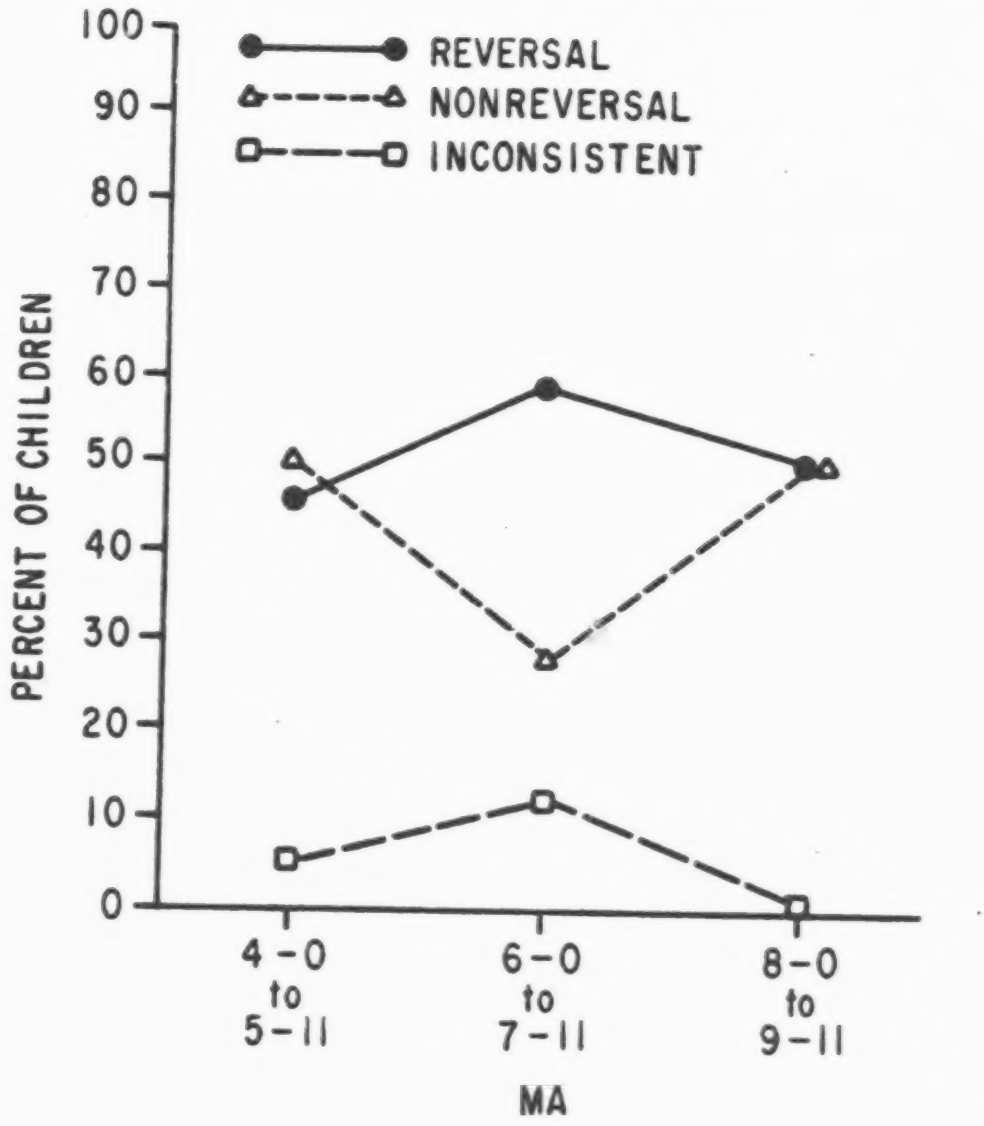

Fig. 8. Percentage of children at each MA level responding in each category.

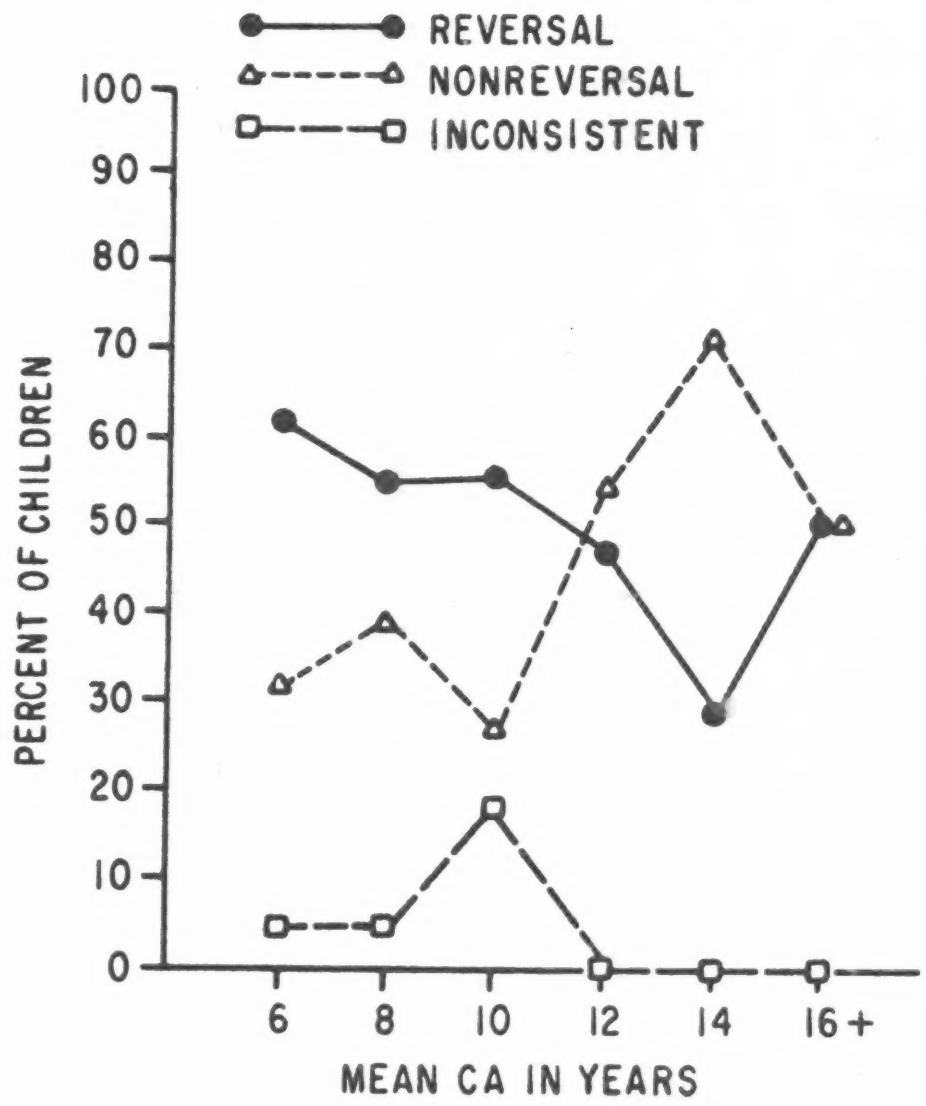

Fig. 9. Percentage of children at various levels of chronological age responding in each category.

Figure 8 illustrates quite clearly the curvilinear relationship between MA and percentage of reversing Ss, as characterized by an increase from MA 5 to MA 7, followed by a nearly corresponding decrease to MA 9. Note also the nearly opposite performance for nonreversers. Again, the small N for the inconsistents makes impossible any meaningful statement about that group.

Although determination of the relation of CA to mediation was not basic to the present research, Figure 9 shows the relation between CA and the percentage of Ss who made a reversal shift. Note that there is a decline in the percentage of reversers with increasing CA, up to the age of 14. This finding suggests a negative relation between CA and mediation, which is in contrast to the results obtained by Kendler, Kendler, and Learnard (1962). Their study differed from the present, however, in that they worked with normal children rather than with retardates, and were concerned with the relation between mediation and CA, rather than the interrelations between mediation, MA and IQ. However, it should be pointed out that because Ss in the present study were matched on MA and IQ, IQ decreased with increasing CA. Consequently, the decrease in percentage of reversers with increasing CA may be an artifact. Moreover, an eta computed between CA and number of reversers was not significant (eta = .15).

It will be recalled that the main concern of this study was with the changes in percentage of mentally retarded children who would mediate as a function of increasing MA, and of increasing IQ. Mediation was inferred as occurring when a reversal shift was made.

The first hypothesis of the study was that with increasing mental age there would be an increasing percentage of children who would mediate, regardless of IQ. The results failed to support this hypothesis, and thus suggests that between the mental ages of four and ten in mentally retarded individuals, MA is unrelated to mediational ability as measured in this experiment.

The second hypothesis was that an increasing percentage would mediate as IQ increased. This hypothesis was verified with the qualification that while mediation increased with greater IQ, the increase occurred not among all levels of IQ but between the lower two combined, and the upper two combined, i.e., at the 70 IQ level.

One implication of this finding is that teaching and training procedures with the retarded must be sensitive to the suggestion that IQ is the critical variable insofar as learning involving mediational processes is concerned. Furthermore, for the lower IQ levels, i.e., IQs between 50 and 70, functioning beyond that implied by single-unit theory is not to be expected for the majority. But perhaps the picture is not altogether discouraging. Note, for example, that Table III shows that in every MA-IQ category there were some Ss who mediated. This suggests that large individual differences in mediational ability exist among the retarded at the same MA-IQ levels. There is little in the way of experimental evidence to aid in the attempt to explain these differences. One hypothesis that might be raised is that these individual differences are a function of differences in past learning experiences and

reinforcements. Further experimental work is needed, however, before the basis of the differences in performance can be adequately understood.

Some research investigating factors possibly affecting the transition from nonmediational to mediational behavior has already begun, however. The variable receiving the greatest attention has been that of the ability to attach verbal labels to the stimuli in a discrimination learning task. It has been hypothesized that the ability to appropriately name the stimuli can facilitate learning on a discrimination task. Two pertinent studies have been carried out with normals by Kendler, Kendler, & Wells, 1960; and Kendler, Kendler, & Learnard, 1962. In the first study, the Ss were pre-school children, while in the second study children at various chronological age levels from three to ten served as Ss. Both studies failed to show that attaching verbal labels to the stimuli had any facilitating effect upon mediation. Further work is necessary, however, before any conclusion can be safely arrived at regarding the relation between language and learning.

One of the most encouraging studies is that by Campione, Hyman, & Zeaman (1965) which investigated the facilitative effects of overlearning on discrimination reversal learning. The Ss in this study were retarded children whose MAs ranged from 30 to 73 months, with a mean of 51.2 months. IQs ranged from 20 to 60 with a mean of 34.8. Stimuli used were three-dimensional objects differing in form and color. Overlearning a reversal shift took place. This was followed by a second reversal shift on the same dimension, but with different cues. It was found that overlearning facilitated

mediation as indicated by improvement in learning the second reversal shift. Thus, while there now is some evidence that mediational ability can be developed under some conditions, the results of the present study suggest that the greatest benefit will accrue to those of IQ 70 and above.

Although the comparison of mediators and nonmediators in terms of speed of learning in Series I and II was not basic to the present study, Kendler, Kendler, & Learnard (1962) have discussed such a comparison in considerable detail. Accordingly, it was decided to analyze further the data of this study along these lines.

Before looking at those data, however, the present finding that the IQ variable is critical to mediation in Series III while MA is not, served as the basis for investigating the relation between IQ, as well as MA, and number of trials needed to reach criterion in Series I and II. In other words, the purpose was to see if the difference between upper two and lower two IQ levels found for reversal learning (Series III), would also hold for initial discrimination learning (Series I), and for reversal shift learning (Series II).

Table IX shows the number of trials to criterion in Series I and II for upper two IQ levels combined, and for lower two IQ levels combined. Table X shows the number of trials to criterion in Series I and II for the three MA levels. In each case the figures represent the number of trials beyond the nine which constituted the reaching of criterion. Table IX shows that IQ is unrelated to initial discrimination learning (Series I), and to reversal shift learning (Series II).

TABLE IX

NUMBER OF TRIALS TO CRITERION IN SERIES I AND II FOR HIGH AND LOW IQ GROUPS

	IQ	N	Range	Mean	Median	s	F	P	t	P
SERIES I:	70-90	36	0-123	19.25	6.5	28.36	1.6	n.s.	.84	n.s.
	50-70	36	0-105	14.14	6.0	22.26				
SERIES II:	70-90	36	1-31	5.44	3.08	6.71	1.84	n.s.	.42	n.s
		36	1-19	4.11	2.25	4.95				

TABLE X

NUMBER OF TRIALS TO CRITERION IN SERIES I AND II FOR THE THREE MA GROUPS

	MA	N	Range	Mean	Median	s	F	P
SERIES I	8-0 to 9-11	24	0-37	9.04	7.17	10.11		
							3.86	.001
	6-0 to 7.11	24	0-64	17.46	5.50	19.86		
							3.46	.01
	4-0 to 5-11	24	0-123	23.58	7.50	36.94		
SERIES II	8-0 to 9-11	24	1-17	4.00	2.32	4.49		
							1.12	n.s.
	6-0 to 7-11	24	1-19	3.42	1.95	4.24		
							3.36	.001
	4-0 to 5-11	24	1-31	6.92	3.75	7.77		

Table X, however, shows that the performance of each MA group as a whole improves with increasing MA level. In Series I there is a significant difference between all three MA levels, whereas in Series II significance was found only between the lower two MA levels. All these differences are due to a significant decrease in the variance within each MA group with increasing MA level, as the results of the F tests indicate. Note also that vast differences in range accompany the significant differences between MA levels. These differences in range are due almost entirely to the improved performance of the slow learners with increasing MA level. Note the fact that the medians for all MA levels are quite similar. In other words, the significant differences between MA levels is due mainly to the improvement in performance of the Ss above the median, i.e., the slow learners.

Thus, while IQ is the critical variable for mediation in Series III, MA level, at least for slow learners, appears to be a critical variable for the learning of the initial discrimination (Series I), as well as the discrimination reversal (Series II).

That IQ is unrelated to performance in Series I and II while MA is, at least for the slow learners, strongly suggests that the level of task difficulty is an important factor in accounting for the results. It was this factor which Zeaman & House (unpublished manuscript) concluded as being the critical factor in accounting for the existence of both positive and negative findings among studies relating IQ to learning. Tasks which are at a low level of difficulty fail to differentiate in the expected direction between

individuals of low and higher levels of ability. In short, performance is attenuated in the case of brighter individuals when a task of low difficulty level is used.

It was previously stated that Kendler et al. (1962) raised the question of the comparison between reversers and nonreversers in terms of speed of learning in Series I and II. In their study, there were significant differences between reversal, nonreversal, and inconsistent Ss in trials needed to reach criterion in both Series I and II. In both of these series, criterion was reached fastest by reversal Ss, followed by nonreverserss, then by inconsistent Ss. Table XI shows the corresponding data for this study, with appropriate statistical tests. Again, no statistical tests were done for inconsistent Ss because there were only five such cases. From Table XI it will be seen that there is no significant difference between reversal and nonreversal Ss in trials to criterion in Series I. In Series II, however, there is a significant difference (P .001) in the variances with respect to number of trials to criterion for reversers and nonreversers, with the reversers having the greater variance. The findings regarding performance on Series I and II do not agree with those of Kendler et al. (1962). It is important to remember, however, that no direct comparison can be made between that study and the present one because this study used retardates as Ss while Kendler et al. used normals. The most that can be said from the results of the present study is that among retarded individuals there appears to be no significant difference in performance on Series I between mediational and nonmediational

TABLE XI

NUMBER OF TRIALS TO REACH CRITERION IN SERIES I AND II AS RELATED TO CHOICE-BEHAVIOR IN SERIES III

	Choice	N	Range	Mean	Median	s	F	P
SERIES I	Reversal	37	0-132	16.22	14.50	23.92	1.17	n.s.
	Nonreversal	30	0-114	16.23	16.07	25.77		
	Inconsistent	5	0-90	23.00				
SERIES II	Reversal	37	1-31	4.92	2.25	6.79	3.19	.001
	Nonreversal	30	1-19	3.93	2.50	3.79		
	Inconsistent	5	1-19	8.80				

Ss, but that there is in Series II.

Although a direct comparison between both cannot be made, an interesting comparison can be made in terms of an important theoretical issue. It will be recalled, as reported in the first chapter, that Kendler et al. (1962) theorized that the inconsistent group represented the lowest level in the hierarchy of developmental levels, with nonreversers next and reversal Ss representing the highest level of performance. Of the Ss in that study, approximately 20 per cent were in the inconsistent category. If inconsistent Ss do in fact represent the lowest level, one would expect to find a greater percentage of inconsistent Ss among a population of retarded individuals than among normals. In the present study, however, there were only seven per cent of Ss who were inconsistent. The major finding of this study, however, namely, that the percentage of mediational Ss increases with increasing IQ, and that the number of nonmediational Ss decreases with increasing IQ, is in agreement with Kendler's hierarchy hypothesis insofar as mediators and nonmediators are concerned. But the fact that the percentage of inconsistent Ss in this study is much less than that in Kendler's study, strongly points to the need for further research regarding the hierarchy of developmental levels of learning.

The results of this study further indicate the need for follow-up investigations regarding the apparent critical relationship between the 70 IQ level and mediational learning.

CHAPTER IV

SUMMARY AND CONCLUSIONS

In recent years there has been an increasing interest among psychologists in the investigation of learning processes among retarded individuals. Much of this interest has centered on discrimination learning, and especially discrimination reversal learning.

Two major theoretical positions, namely, single-unit S-R theory and mediational S-R theory have been developed which provide a basis for interpreting performance on these two learning tasks. Single-unit S-R theory assumes a direct association between environmental stimuli and overt responses. Mediational S-R theory, however, assumes that an external stimulus evokes an implicit response which produces an implicit cue that is connected to the overt response.

One learning situation which has been used to demonstrate both theoretical positions is that which follows the now-classical learning paradigm of reversal and nonreversal shifts (Kendler & Kendler, 1962). Kendler, Kendler, & Learnard (1962) used this model to show that with normal children there was an increase in the proportion of children achieving a reversal shift as CA increased. Reversal shift behavior served as the basis for inferring mediational ability. Their results supported Kendler's hypothesis that there is a hierarchy of developmental levels of learning ability, which in descending order are reversal learning (i.e., mediation),

nonreversal learning (i.e., nonmediation), and inconsistent functioning.

The above investigators related mediation to chronological age (CA) in children of normal ability. Other research, however, suggests that CA by itself is an inadequate index of learning ability in the retarded, and that the critical variables to investigate are mental age (MA), IQ, and their interaction. For the purposes of this study, the paradigm and an apparatus similar to that used by Kendler and Kendler (1962) were used to investigate the interrelations between MA, IQ, and mediation in mentally retarded individuals.

The original hypotheses of interest were:

1. Regardless of IQ, the percentage of mentally retarded individuals mediating is a monotonically increasing function of MA.

2. Regardless of MA, the percentage of mentally retarded individuals mediating is a monotonically increasing function if IQ.

Since there is a real need for greater understanding of learning phenomena in retarded children within the public school system, the Ss used in this study came from classes in special education in the public schools of Salt Lake and Davis counties in Utah. The 72 Ss used in this experiment were selected so as to fall into 12 MA-IQ categories, with six Ss per category, equally distributed with respect to sex. These categories consisted of four levels of IQ: 50-59, 60-69, 70-79, 80-89; and three levels of MA: 4-0, to 5-11, 6-0 to 7-11, 8-0 to 9-11. Intellectual evaluations were based on the Stanford-Binet Intelligence Scale, Form L-M, administered within the past year.

The apparatus alternately displayed two pairs of stimuli. One pair consisted of a large black square and a small white square, while the other pair consisted of a large white square and a small black square.

The experiment was made up of three series of trials which were run without interruption between them. In Series I, both pairs of stimuli were used and S was reinforced for a response to black in each pair, regardless of size. In Series II, only one of the pair of stimuli was used and S was reinforced for a response to white (discrimination reversal). In Series III, both pairs of stimuli were presented. The S continued to be reinforced for a response to the white square used in Series II. However, for the pair not used in Series II, he was reinforced for a response to either the white square or black square. If S in Series III chose the white square of this pair eight or more times in ten trials, he was considered a reverser, i.e., mediator. If he chose the white square two or less times out of the ten trials, he was considered a nonreverser, i.e., nonmediator.

If he chose the white square between two and eight times, he was considered to be an inconsistent S. Reinforcement consisted of one penny given for every correct response, and one penny taken from S for an incorrect response, on all three series of trials.

Two separate analyses of variance (with MA and IQ the independent variables) were done on the data, one for total number of reversal shift responses, the other on number of Ss achieving a reversal shift. While significance was not achieved in either of these analyses, results of an individual

degree of freedom test (Li, 1957, pp. 228-229) showed a significant increase in both number of mediational responses and number of mediators, between IQ level of 50-69, and 70-90. Chi square (X^2) were also significant between these two IQ levels in both cases. Significance was not found with respect to any levels of the MA variable.

Since Kendler, Kendler, & Learnard (1962) had found that mediators learned significantly faster than nonmediators in the initial discrimination task (Series I) and in the discrimination reversal task (Series II), data in this experiment were analyzed accordingly. Previous analysis of the data in Series I and II showed no significant differences in trials to criterion for the IQ variable. But there was a significantly better performance within MA groups with increasing MA, which was due to a reduction in the variance resulting from the better performance of the slow learners.

In regard to the performance of reversers and nonreversers in trials to criterion, no difference was found in Series I. In Series II, however, the performance of the nonreversers was significantly better than that of the reversers due to the greater variance in number of trials to criterion for the reversers. Only five Ss were in the inconsistent category in the present study.

The hypothesis that mediation would increase with increasing MA was not confirmed.

The hypothesis that mediation would increase with increasing IQ was confirmed, with the qualification that the significant increase occurred between the the two lower IQ categories combined and the two higher IQ categories combined.

In comparing present findings with those of Kendler et al, (1962), it is clear that the results of the performance of reversers and nonreversers in this study were contrary to those obtained by those investigators. Present findings suggest that for mentally retarded individuals there appears to be no significant difference between reversers and nonreversers in Series I, while in Series II the performance of the nonreversers was significantly better.

Furthermore, it was felt that direct comparison with the study of Kendler et al. (1962) was not feasible because of the different nature of the Ss used. One aspect of Kendler's hierarchy of developmental levels of learning appeared to be in question because the percentage of inconsistent Ss was much lower in this study than Kendler et al. (1962) obtained with normals. Since they hypothesized that inconcistent Ss are at the lowest developmental level of learning, one would expect a higher percentage among retardates, but this was not found to be the case.

On the other hand, one finding of the present study, namely, that mediation increased with increasing IQ, supported the hierarchy hypothesis with regard to mediators and nonmediators.

The results of this study further indicated the need for follow-up investigations regarding the apparent critical relationship between the 70 IQ level and mediational learning.

BIBLIOGRAPHY

BUREAU OF EDUCATION FOR THE HANDICAPPED
DIVISION OF RESEARCH

PROJECT NO: 6-8127 (Final Report)

TITLE: Test Response Patterns Which Differentiate Between Two Levels of Behavior of Mentally Retarded Children

AUTHOR: James D. Boswell

INSTITUTION: University of Utah
Salt Lake City, Utah

RECOMMENDATION: Approval

SUMMARY OF REVIEWS

This report has been reviewed by Division of Research staff. Since prior commitments had been made regarding the acceptability of the investigator's dissertation, it was not considered effecient to submit the report to the full field review process. Therefore we are recommending approval of the report on the basis of staff review. The report is viewed as appropriate for submission to ERIC.

Consistency with Proposal

It appears that the research was conducted as proposed in all essential respects. It is disappointing that obtained results were not interpreted more directly in terms of educational implications, but expectations in this area were only implied in the proposal.

Adequacy of Reporting

The experiment is reported quite completely, to the extent that replication or reinterpretation of the data is easily possible. The discussion and implications drawn are quite remote from educational needs, but this may be a function of requirements of the dissertation.

Educational Significance

As presented the report has very limited potential for effecting educational practice with the retarded. The study was designed as a basic test of theory and was interpreted in like manner. This is unfortunate from the point of view of our program, but is not a valid criticism of the effort since directly appliable results were not originally anticipated.

Technical Quality

Format, editing, reproduction, etc. are consistent and adequate.

BIBLIOGRAPHY

Baumeister, A. A., Beedle, R., & Urquhart, D. GSR conditioning in normals and retardates. American Journal of Mental Deficiency, 1964, 69, 114-120.

Buss, A. H. Reversal and nonreversal shifts in concept formation with partial reinforcement eliminated. Journal of Experimental Psychology, 1956, 52, 162-166.

Denny, M. R. Research in learning and performance. In Stevens, H. A. & Heber, R. (Eds.), Mental retardation: a review of research. Chicago: University of Chicago Press, 1963.

Ellis, N. R. Object-quality discrimination learning sets in mental defectives. Journal of Comparative and Physiological Psychology, 1958, 51, 79-81.

Ellis, N. R., Hawkins, W. F., Pryer, M. W., & Jones, R. W. Distraction effects in oddity learning by normal and mentally defective humans. American Journal of Mental Deficiency, 1963, 67, 576-583.

Ellis, N. R., & Sloan, W. Oddity learning as a function of mental age. Journal of Comparative and Physiological Psychology, 1959, 52, 228-230.

Harrow, M., & Friedman, G. B. Comparing reversal and nonreversal shifts in concept formation with partial reinforcement controlled. Journal of Experimental Psychology, 1958, 55, 592-597.

Harter, S. Discrimination learning set in children as a function of MA and IQ. Journal of Experimental Child Psychology, 1965, 2, 31-43.

Hetherington, E. M., Ross, L. E., & Pick, H. L., Jr. Delay of reward and learning in mentally retarded and normal children. Child Development, 1964, 35, 653-659.

Hoffman, D. T. (with House, B. J. & Zeaman, D.) Miniature experiments in the discrimination learning of retardates. In Lipsitt, L. P., and Spiker, C. C. (Eds.) Advances in child development and behavior. Vol. I., Academic Press: New York, 1963.

House, B. J., & Zeaman, D. A comparison of discrimination learning in normal and mentally defective children. Child Development, 1958, 29, 411-416.

House, B. J., & Zeaman, D. Visual discrimination learning and intelligence in defectives of low mental age. American Journal of Mental Deficiency, 1960, 65, 51-58.

Kass, N., & Stevenson, H. W. The effect of pretraining reinforcement conditions on learning by normal and retarded children. American Journal of Mental Deficiency, 1961, 66, 76-80.

Kelleher, R. T. Discrimination learning as a function of reversal and nonreversal shifts. Journal of Experimental Psychology, 1956, 51, 379-384.

Kendler, H. H., & D'Amato, M. F. A comparison of reversal shifts and nonreversal shifts in human concept formation behavior. Journal of Experimental Psychology, 1955, 49, 165-174.

Kendler, T. S., & Kendler, H. H. Reversal and nonreversal shifts in kindergarten children. Journal of Experimental Psychology, 1959, 58, 56-60.

Kendler, T. S., Kendler, H. H., & Wells, D. Reversal and nonreversal shifts in nursery school children. Journal of Comparative and Physiological Psychology, 1960, 53, 83-88.

Kendler, H. H., & Kendler, T. S. Vertical and horizontal processes in problem solving. Psychological Review, 1962, 69, 1-16.

Kendler, T. S., Kendler, H. H., & Learnard, B. Mediated responses to size and brightness as a function of age. American Journal of Psychology, 1962, 75, 571-586.

Li, J.C.R. Introduction to statistical inference. Lancaster: The Science Press, Inc., 1957.

Luria, A. R. The role of language in the formation of temporary connections. In B. Simon (Ed.), Psychology in the Soviet Union. Stanford: Stanford University Press, 1957, 115-129.

Martin, W. E., & Blum, A. Interest generalization and learning in mentally normal and subnormal children. Journal of Comparative and Physiological Psychology, 1961, 54, 28-32.

Milgram, N. A., & Furth, H. G. Position reversal vs. dimension reversal in normal and retarded children. Child Development, 1964, 35, 701-708.

O'Connor, N., & Hermelin, B. Discrimination and reversal learning in imbeciles. Journal of Abnormal and Social Psychology, 1959, 59, 409-413.

Plenderleith, M. Discrimination learning and discrimination reversal learning in normal and feebleminded children. Journal of Genetic Psychology, 1956, 88, 107-112.

Rieber, M. Verbal mediation in normal and retarded children. American Journal of Mental Deficiency, 1964, 68, 634-641.

Rudel, R. G. The absolute response in tests of generalization in normal and retarded children. American Journal of Psychology, 1959, 72, 401-408.

Sanders, B., Ross, L. E., & Heal, L. W. Reversal and nonreversal shift learning in normal children and retardates of comparable mental age. Journal of Comparative and Physiological Psychology, 1965, 1, 84-88.

Spence, K. W. The nature of discrimination learning in animals. Psychological Review, 1936, 43, 427-449.

Stevenson, H. W. Learning of complex problems by normal and retarded Ss. American Journal of Mental Deficiency, 1960, 64, 1021-1026.

Stevenson, H. W., & Odom, R. D. Interrelationships in children's learning. Child Development, 1965, 36, 7-19.

Stevenson, H. W., & Iscoe, I. Transposition in the feeble-minded. Journal of Experimental Psychology, 1955, 49, 11-15.

Stevenson, H. W., & Zigler, E. F. Discrimination learning and rigidity in normal and feeble-minded individuals. Journal of Personality, 1957, 25, 699-711.

Zeaman, D., & House, B. J. The relation of IQ and learning. Unpublished manuscript, (1965).